THE AMERICAN

MONTHLY

Microscopical Journal.

VOLUME 19,

FOR

1898.

Founded in 1880 by R. Hitchcock, and published since 1887, by
Chas. W. Smiley, Washington, D. C.

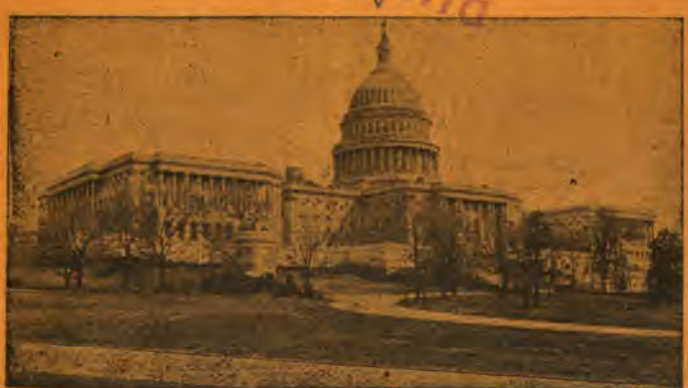
Vol. XIX, No. 1. JANUARY, 1898. No. 217

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL

ILLUSTRATED



Chas. W. Smiley, Publisher,
Washington, D. C.

Terms: For the U. S., $2.00.
For Great Britain, 8s.

THE AMERICAN

7363

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. JULY, 1898. NO. 7.

Contents.

Microscopic Images and Vision.

BY LEWIS WRIGHT.

(Concluded from Page 104.)

15. We therefore next consider that illustration. To begin with, the resolution of *A. pellucida* is no real problem at all: it is not even of the same nature as the problems which do confront the scientific worker. Supposing it were, the latter would regard with consternation the elaborate apparatus described for producing monochromatic light. This diatom, however, has been studied for many years; the dimensions of its structure are known and familiar; and the powers of annular illumination have long since been ascertained. It is no problem, or one in which help is needed, to take what is really a "grating" of this *known* fineness, and already *known* to have this definite periodicity of structure, and arrange matters so as to get the most conspicuous "resolution" of it. The problems in which assistance is really wanted, the microscopic worker's really "difficult" objects, are such as Dr. Dallinger confronted

in detecting the spores of a monad, itself only 1-6000 of an inch in diameter and themselves only 1-240000 of an inch; or more especially (because here was involved real "resolution" of fine detail) the *process of division* in the nucleus of a cell, itself only 1-20000 of an inch long. In such cases what will be found and is to be observed is *unknown*; accurate periodicity of structure is probably absent; and mere artificial force of clearness in "resolution," even if obtainable (which it seldom is) is worthless in comparison with known trustworthiness in the image so far as it goes. Taking any such case as this for our test-object, and comparing it with the treatment of the *A. pellucida* as described, we shall be able to appreciate the proportion of both truth and error—for there is truth as well as error—in the "spectrum" theory.

16. We cannot help, in the first place, seeing much error. While the minuteness of structure to be detected by Dr. Dallinger (in an unknown object) was as great, the method of proceeding described for the *A. pellucida* is impracticable, and would be useless even if practicable, real work has to be done by far different means. The finest lenses, used with a wide and solid aplanatic cone of light, could alone do such work; and moreover, earlier lenses of 1·48 N. A. were surpassed in results by apochromatic lenses of 1·40 N. A., better corrected for spherical aberration—the meaning of which we shall see. Supposing the microscopist, however, to know or suppose the measure of minuteness in the divisions of the cell-nucleus, he would have to employ (with doubtless some modification in detail) arrangements for *plane-wave illumination* generically similar to those he describes for the diatom. But he would be wrong, and the results would be *nil.*

Narrow pencils and annuli have of course been tried, for the contrast they give. The probable reason of failure is want of sufficiently regular *periodicity* in the detail. Only such periodic detail is shown better by

elaborate notes for the benefit of those persons who wish to make a serious study of the objects or to gain experience and efficiency in somewhat advanced fields of research. These boxes each contain one botanical and one zoological specimen. Most of the notes have been made by Dr. Ward, Dr. Shanks and C. M. Vorce. Others are invited to contribute for next year. Some of the members have testified their high appreciation of the boxes and the notes as being superior to any of past years.

The membership is divided into circuits. While a box is passing through a circuit, including six or eight addresses, it is out of sight of the Secretary. If the box fails to complete its circuit on time, the Secretary is put to great trouble in tracing it. This is where "one sinner destroyeth much good." Last year a circuit was necessarily dropped because no boxes could be got through it or could even by any amount of special effort be got back from it except after months of delay which was simply ruinous to the plans of the officers. It would give us pleasure to publish the names of the members of that circuit if the officers would kindly furuish them to us. If, however, they neglect the system of fines, suggested above, they will loose a part of our sympathy. There are some vacancies in the well behaved circuits and co-operation is desired in finding suitable persons to be made new members.

SCIENCE-GOSSIP.

Preserving Media for Biological Preparations.—The following fluids are recommended by Amann for preserving biological specimens: *Lactophenol*: Carbolic acid, 20; lactic acid, 20; glycerin, 40; distilled water, 20 parts. Recommended for fronds of mosses, hepaticæ, fungi, and algæ. *Lactophenol copper solution*: Crystallized chloride of copper, 0·2 part; crystalised acetate of copper 0·2 part; distilled water, 95·0 parts; lactophenol, 5·0 parts. For preserving chlorophyll, recommended for Demidiaceæ, Palmadaceæ, Confervæ, etc. *Concentrated lactophenol copper*

solution: Crystalized copper chloride, 2·0 parts; crystallised copper acetate, 2·0 parts; lactophenol, 95·0 parts; water containing algæ is mixed with 10 per cent of the above solution. The whole material is preserved thereby for a long time. *Lactophenol glycerin jelly*: White gelatin, 85; distilled water, 44; glycerin, 30; dissolve by heating on the water bath, filter and mix with 10 parts of lactophenol. *Lactophenol copper glycerin jelly*: Prepared as above with the substitution of 10 parts of lactophenol copper for lactophenol. Phyocyanin and chlorophyll retain their color excellently in this medium. *Lactophenol gum*: A strong solution of gum arabic in water 1, glucose 2, and lactophenol. For preparing mosses for the herbarium. *Potassium mercuric iodide glycerin*: The author states that the salt dissolved in concentrated anhydrous glycerin gives a mounting medium of 1·78 to 1·80 refraction index. He recommends the mixture for Diatomaceæ. The preparations are ringed on with amber or dammar varnish mixed with two per cent of boiled linseed oil.—*Pharm. Centr.*, xxxviii., 544.

Astronomy.—The microscope is useful in astronomy—(1) As applied to the graduated arcs of measuring circles in astronomical instruments of precision, and to the fine divisions on the measuring rods used in determining a base-line,—the fundamental measurement in astronomy. The microscope micrometer, which contains the microscope as an essential part, is used extensively; (2) In the measurement of the position of stars on the Astro-Photographic Chartsand plates obtained by the International Congress for their catalogue of all stars of the first eleven magnitudes; (3) In the determination of differential stellar parallax from photographic plates; (4) In the study and observation of the heavenly bodies as advances in astronomical photography make it possible to produce slides of sufficient fineness for the purpose.

Woods.—L. W. Hahn, Silver Creek, N. Y., offers 110 varieties of foreign and native woods for $3.00.

such methods; all else is "blurred." Dr. Dallinger had to do such work with a high degree of heterogeneous illumination—as close an approach as is possible with the lens used, to a self-luminous condition of the object.

The image even of the diatom is a false image. It is admittedly so in regard to the "spherules," and competent judges are very doubtful whether even the breaking up of the striæ so shown, is not due to false diffraction-fringes from the midrib of the valve, the spherules being thus arranged in longitudinal rows far more straight than is really the case. Looking at the matter theoretically, it will be observed that after having laid down how the excellence of the image is in inverse proportion to "the degree in which [the state of the light by which the object is illuminated] contributes to produce, to modify, or to efface detail," he proceeds to obtain this image by almost the greatest specialization of the light which is possible. The effect of this is to replace the actual detail, by other apparent detail which is visually intense, and geometrically symmetrical, to an utterly false degree.

Similar results are traceable in other diatom work by the Abbe school, as may be shown by the most familiar test-valve of all, a much coarser one, the *P. angulatum*. Dr. Van Heurck has photographed this with the celebrated Abbe-Zeiss lens of 1·63 aperture and dense immersion-fluid and medium, by Abbe methods, with an uncorrected condenser; the result is a series of hexagons resembling a honey-comb. Dry objectives can only image details "correctly so far as regards their number and position, but any further detail is not correctly represented." Immersions embracing most of the first spectra, "we now see some detail: the dots appear hexagonal, and are separated from one another by walls which are thin, and which look like a honey-comb;" and "this is the first and only step we can take towards

learning what the actual detail is," because no objective will embrace the other orders. Examining these several statements, there is every reason to believe that a dry objective with a wide cone of light gives a perfectly truthful image, while it will give the hexagons quite easily if that figure is preferred; Zeiss's well-known large-scale photograph is of a value so coarse that it is beyond dispute that a portion of the second-order spectra *were* included by the lens used, with the result of introducing a false *doubled* resolution impossible with first orders alone; and an immense further step can be taken by using a first-rate immersion-lens of 1·40 aperture, with a wide cone. The Zeiss photograph ×4900, and the Van Heurck photograph, are confessedly the highest triumphs of photography by the Abbe method: one has only to compare both with the beautiful photograph ×4900 taken in this other way by Mr. E. M. Nelson, and other similar ones up to a scale of ×6400, to *see* once for all, which is the truest image, and the all-importance of a sufficiency of heterogeneous light.

The minute detail in some of these photographs could not possibly be shown by that method, because, minute as they are, they are *unsymetrical* and not *periodic*. In regard to the *P. angulatum*, both circular disks and hexagons can be seen, depending upon the precise focus; the sharpest portions show the circles, which, disposed in quincunx arrangement, most diatomists who have worked with English appliances believe to be the true figure. Besides the sharpest image, we have the phenomena of "postage-stamp fracture," and the shape of far coarser markings in other diatoms to guide us. Mr. C. Haughton Gill has demonstrated that the spots are either apertures or depressions, by depositing pigment in them; and the various images can be imitated with perforated zinc. It is the distinct outlines of the *fractures*, and broken-through apertures, which are so

magnificently shown in Mr. Nelson's photograph with a wide cone.

17. We can also, however, see the large amount of *truth* in the Abbe theory, and its important, though not *all*-important, place in microscopic vision, especially for certain classes of objects. Wherever we have a known periodic structure in transparent objects, plane-wave illumination and the consequent interference-lines formed by the beams diffracted by that structure, have an extraordinary effect in *intensifying* into black and white a more or less accurate representation of the periodic detail. How this occurs can be easily seen from two examples, macroscopic and microscopic.

Take first quite a coarse striation of 50 to the inch, visible to the naked eye, represented by a grating of platinum wire and by a piece of platinum foil corrugated to the same gauge. Make the wire incandescent, and (checking irradiation by a smoked glass) the striation is easily seen. Make the corrugated foil incandescent (these observations are supposed to be in the dark) and probably the detail will be quite invisible. The eye was quite competent to see structure of this fineness by the Airy self-luminous method, if the detail was in contrast; but there is now no *contrast*, and the detail is more or less invisible. Then let the corrugated foil be cold and illuminated by extraneous light, and the detail is seen again. There is both *shadow* to assist the contrasts, and also there are phase-relations between the tops and bottoms of the striations which come into play.

Let us further imagine a perfectly transparent structure with uniform periodic detail, but the elements of that detail differing in thickness only; and let it be mounted in a medium of nearly the same refractive index. A diatom in balsam nearly represents such a case. It is quite evident that by heterogeneous illumination at all approaching the self-luminous character, it

will be difficult to find anything *sufficiently contrasted* in detail to see at all, though the very same illumination of a *black-and-white* photograph of small scale, or of the same diatom in a medium of 2·4 index, might show it easily. But plane-wave illumination might very easily bring about phase relations more or less approximating to *half-wave discordance*, which we know well would be more effective than black-and-white itself by direct light; in any case these phase-relations will produce conspicuous effect in a Fresnel-fringe image. Thus the Abbe method has a most important function in enabling us to see *contrast* in the details of a large class of objects—especially hyaline or transparent objects—which do not present contrast or opacity sufficient to be seen in any other way. The error has been in giving to it the sole or all-important place, not recognizing that there is quite another kind of image also available, depending upon Airy's theory; and that this latter, while in the the case of transparent details often giving images insufficient, or at least far inferior, in black-and-white contrast (what microscopists call "resolution"), is free from the *contour* errors of the Abbe image, and must be used to correct it so far as is possible in the individual cases.

The errors of the "spectrum" image are well known: Prof. Abbe himself has sufficiently insisted upon them. Its very contrast, or "resolution," is in most cases a glaring departure from *truth*, to which (when we can get resolution at all) the more indistinct self-luminous image is in reality a far nearer approach. It tends to make details which should be only geometrically symmetrical to a limited extent, perfectly so. In extreme forms it makes rows of spots into lines, and these lines straight when not really so. It is always liable to false resolutions of double fineness. It fails to give even a tolerable image of the larger features of the object, thereby showing its failure to be a real "image" at all. All

that can really be learnt from it, is that there is probably (for this is subject to possible delusion from the false intercostals above mentioned) *some* periodic difference of structure in the object *similar in dimentional intervals* to "lines" shown: in regard to "spots" this is more uncertain, since these are often produced by false diffraction-fringes from any long line which may cross the true ones. That the lines are lines, or that the "pattern" is so geometrical as appears, is in the highest degree improbable. That the "spectrum" theory and method so long retained exclusive predominance, is because attention has been so concentrated upon either gratings or diatoms of *known periodicity* in structure, but which only represent to a very small extent indeed any serious kind of investigation.

18. It appears that in microscopy we have to deal with two characteristics of an image, which often are only to a limited extent compatible; that we have at command two methods of illumination which respectively promote more especially each of such characteristics; and that in most cases our problem is so to combine and balance these two methods as to produce the best result. *Fidelity of contour* will be secured in proportion as we are able to obtain our image by heterogeneous illumination, approximating the object to a self-luminous condition. But this method may prove utterly unable to give us *contrast*, which we may therefore be compelled to increase by using to a greater or less (even to a very large) extent plane-wave illumination, at the expense, however, of some greater or less degree of infidelity in contour. Thus an opaque subject, even of much minuteness, may be best shown by ground-glass illumination, or a very wide cone; while a diatom, unless in a very dense medium, or dry in air, may require narrow pencils of approximately plane waves. It is interesting to observe that there is thus a great degree of practical truth in

Prof. Abbe's early contention as to "different origins" of different parts of the image. Many of us have written of this as an "error," now "recanted," which strictly is true; but there is this broad practical sense in which it also is true.

And we are unable to use either kind of image or of illumination absolutely pure, if we desired to do so. The narrowest pencil we can practically use will not give us absolutely plane waves alone; there will be some amount of heterogeneity in the pencil, which in some little degree serves to *correct* our image. And the widest cones we can use, or even ground glass, do not prevent greater or less approach to the character of plane-waves, as the rays travel farther from the lamp; and these by their interference tend to *intensify* the image. We have to play off and adjust one against the other. In so far as we may regard every elementary or excessively small cone or pencil of rays from the condenser as an individual beam of plane waves (which no doubt is the case in some degree), in passing through the object it originates two or more pencils from the same point. These being necessarily in the same phase or phase-relation, so far as they exist must interfere at the focus, and thus *intensify* the image. On the other hand, the numerous such elementary pencils comsrising a wide cone, are in many discordant phases and transversals, and this very heterogeneity tends to correct the *contours* in the image, as above. We thus understand why, in really critical work, a large cone from a good condenser usually gives us the best results; but why it may be impossible, even with a perfect objective, to use a cone of light which will fill its aperture completely. It may be necessary, to intensify the image, while using as much heterogeneous light as we can, to use only pencils each of which throws out another diffracted pencil grasped by the aperture, so as to intensify, or correct it. But this

necessity depends on the nature of the object, and does not exist in all cases.

19. There is a very obvious and simple, yet decisive test as to the correctness of this view. According to the Abbe or spectrum theory, the amount of cone or heterogeneous light which can be used will depend upon the *minuteness* of the structure alone. According to the view here maintained (which recognizes the Airy theory as also concerned in the image) the *density or contrast* of the structure is the chief factor in this question. All experience proves that the latter is the case.

It only remains to show how directly the questions here discussed affect practical microscopy and the work of the microscope optician, and also determine the prospect of further advances in our powers of microscopical research.

20. The Abbe or "spectrum" theory has in its time, confessedly, led to enormous improvements in objectives. Owing to that specialization and ignorance of what physicists had done, there was amongst microscopists no understanding of the direct function of aperture in resolution; and so the Abbe theory was for years written about, and advanced as "the first explanation ever given." It thus produced a vivid consciousness of that function which was entirely new, to which we owe our present immersion and other high aperture lenses. But it is as easy to show that, this work being done, its undue preponderence and acceptance as the *only* theory, especially on the Continent, is now causing distinct prejudical results, owing chiefly to its connexion in practice with a narrow pencil or cone. Abbe himself throughout insisted upon the narrow pencil. Dr. Van Heurck does the same; Dr. Peragallo writes that a cone of more than 0·50 N A. is of no use; and Dr. Dallinger, and authorities like him, who in a general way accept the Abbe theory as *the* "theory," but know from their own exper-

ience the vital necessity in difficult research of a wide cone, write expressly of "theory and practice being thus at variance," in some way or other which had to be explained.

It is difficult to estimate the prejudicial effect of this upon microscopy on the Continent. As a quite uncorrected condenser will give a fair cone up to 0·50 N. A., amd also by immersion extremely oblique rays from its margin (equivalent to annular marginal illumination), for years no better Continental condenser was made. Prof. Abbe at last was driven to compute an achromatic, but this last production of Continental microscopy only gives an aplanatic cone of 0·65. Except those few who know of English condensers, with their *aplanatic* cones of 1·10 for immersion and 0·90 for dry conbinations Continental workers have thus been condemned to the errors and weaknesses of narrow pencils, which have thence been propagated through our own medical schools and the results are sufficiently striking. Dr. Koch at last found out, empirically, that wide cones gave much sharper and "finer" images of bacteria, in fact the only images worth having. Prof. Abbe accounted for this observational fact, in an article expressly contradicting any advantage whatever to the image (as an image) from a wide cone, on the ground that the wide cone, owing to its more sharply defined focal plane (want of "penetration"), makes invisible the transparent tissues in which the bacteria are situate. But he fails to account for the fact that it is just the same with bacteria in invisible culture-media or sputum; and that the advantage really consists in the much greater sharpness or *thinness* of the images of the bacteria themselves; in truth of contour, so that square ends are shown square and not rounded; and in the fact that there are no blurred edges or diffraction-fringes around them, as appear with a narrow cone. In fact, many allied bacteria cannot be distinguished at all

by the microscopic methods still too current in our schools, which have taken their methods from Germany.

At the Jena workshop in 1895, Prof. Zimmermann, one of the scientific staff (who has himself published a work on microscopy), said that in photographing they found no difference in results obtained by the chromatic and achromatic condensers; which is equivalent to the statement that they knew of no better results than those from a 0·50 cone. Our results are quite different. Mr. A. Pringle, whose splendid photographic work on bacteria is well known, often uses the largest aplanatic cones; and, Dallinger: "Photo-micrography with a small cone is quite easy, as great contrast can be secured [the reason has been shown in foregoing paragraphs]. With a large cone difficulties begin—difficulties of adjustment, difficulties of lens correction, difficulties of exposure, and difficulties of development. If, so far as our experience goes, a good photo-micrograph is required, these difficulties must be mastered."

21. This quotation leads us to the prejudicial effect of the theory (or rather of its undue preponderance) upon microscopic objectives. The mode of illumination directly influences the quality of the objective; because the all-important point of correction for spherical aberration has commanding influence upon the cone of heterogeneous rays which can be used with it. This does not appear under the Abbe method; and Strahl maintains that "the influenceof spherical aberration has been considerably over-rated in objectives!" The most eminent firm of Continental opticians states that its lenses, owing to the system of calculation and manufacture, are uniformly free from spherical aberration, so much so that there is no need for any "empirical tests," viz., testing upon the microscope itself. That is not the case when tested by the more perfect English appliances. The condenser itself is an English appliance. Ten years ago only one house,

I think, made one with wide aplanatic cone. Today every English house of any standing constructs achromatic combinations with 0·90 of aplanatic cone, and two construct apochromatics. Not long ago, having the opportunity of testing and comparing three similar objectives together, I was enabled to see the difference. With the Abbe condenser there was no very obvious distinction; but tested by English condensers it was quite otherwise. The great firm had no cause to blush for any one of them; all were good lenses; but they now revealed as distinct characteristic features as one sees in individual faces. On a graduated series of *Poduras*, one of them now gave most unusually good definition with rather a small cone under the highest (×27) eyepiece; while a second, scarcely equal in this point, excelled the others in the *wide* cone it was able to use on this object. Another operator more skillful than myself, and certainly of keener vision quite independently reached identical conclusions. Slight variations of pressure in the final polishing of the glasses are quite sufficient to produce such differences as these, in such small lenses as are here in question.

Whether this latter be the cause, or some other, nearly all high-power objectives even of the present day, and of the very best makers, show a very sensible amount of aberration. Drawing a circle to represent the whole aperture, and smaller concentric circles to define zones of its surface, many of the zones have *slightly different foci*. This fact plays all sorts of insidious hanky-panky-tricks with small-cone interference images of the Abbe kind; giving more force to such of the spectra as are correctly focussed than to the others. But in other respects, with small cones, these zonal differences are not obvious, and often escape detection, many portions of the aperture not being utilized at all. There are refined tests familiar to opticians, and some

others employed by highly skilled microscopists; but not only are these too seldom employed by even the best makers before the lens is sent forth, but we have seen that even their necessity is disputed, and the importance of spherical aberration itself actually challenged, by adherents of the "spectrum" theory as heretofore understood.

When, however, we do employ adequate tests, and at the same time make careful comparisons between one objective and another, we find that the perfect correction of spherical aberrations is just *all-important* in determining how far we can go in using with that lens the heterogeneous illuminating cone which is so important for depicting true contours in our image, still preserving sufficient resolution of minute structure. (We are here postulating sufficient opacity in the details, to dispense with much of the aid we have seen to be often necessary in hyaline subjects.) High-class moderate powers now easily utilize their full aperture, with ground-glass illumination. With high powers, the amount of this, or of aplanatic cone possible, is in almost direct proportion to the perfection of spherical correction. Few lenses over 0·60 N.A. will, however, even yet bear more than three-fourths of their aperture as direct light; many very good ones only two-thirds. And objectives differ strangely. In Zeiss's apochromatic series, the half-inch of 0·65 N.A. and the ⅛ immersion of 1·40 stand out from the rest: some rare specimens of the former will bear their full cone, and occasionally an ⅛ of 1·40 has been used in photography with a cone of 1·10. Very recently there was sent me for examination by Messrs Swift, a new English 1-12 apochromatic of 1·40, which was remarkably well corrected spherically. A rough but very fair idea of the spherical correction may be obtained almost immediately by focussing a *Podura* test-scale with small cone and then ascertaining how far the iris can be opened without

altering the image of the exclamation-marks. Using successively larger *annuli* of light, this test becomes far more efficient and severe. It was accordingly tested upon *A. pellucida* mounted in arsenic by Dr. Van Heurck. All the transverse striæ in the diatom were most easily resolved with a central, solid, unstopped full aplanatic cone of over 0·90 from a dry condenser. The larger features were of course also quite correctly and sharply imaged.

But this is not nearly the limit. Owing to some astigmatism and other defects, my vision is very coarse and imperfect in these matters, and for me to see the striæ means much more for many other observers. The first valve Mr. E. M. Nelson showed me in balsam as "strongly" resolved, was to my sight quite unresolvable, and he had to search for another, which I was able to see. This diatom is one of the most variable in resolvability of the whole list, quite apart from the mere coarseness of striation. *That* is no difficulty at all. Since that experiment Mr. E. M. Nelson has shown *A. pellucida* clearly resolved into striæ *mounted in balsam*, as well as "dry," with a similar cone of over 0·90 from Powell's apochromatic condenser, and a Zeiss $\frac{1}{8}$ apochromatic of 1·40. This latter lens was probably one of the finest ever made, and the mere striæ were not all it had to tell us, using no arrangements beyond the 0·90 full cone, and Giffard's green light-filter. On a dry valve, it clearly displayed where bits of coarser upper membrane with their blacker lines were overlying the lower, as is more often seen in *A. Lindheimerii*. And on a strong valve in quinidine, carefully adjusting for what may be termed the "white" focus, each of the striæ could be seen outlined at both edges, the outlines being a series of small convex curves, scalloping out the stria into partly-defined oval beads. The divisions or narrower necks between these partly-defined ovals did not lie in longitudinal rows, but occurred with a considerable degree of irregularity. Such

resolution, which most closely parallels the coarser *Lindheimerii* valve, may be the truest resolution yet attained.

No doubt the above lens was an almost phenomenal one. Every practical microscopist knows that the "similar" objectives, by even the very best makers, are not "all alike," whatever the makers may affirm. They differ in features as in a case above mentioned; most of all in the cone they can employ in critical work, and in what such a cone will reveal. Everyone engaged in difficult research has some favorite objective, treasured and spared in work as much as possible; because he knows full well that if parted with or injured, though he can buy a "similar" one at the list price, it may be long ere he finds such another.

22. The question of how far we may still expect advances in our optical powers of reseach is important; and it is answered very differently according to the "spectrum" theory, or the qualified views here maintained. It not only follows from the foregoing, but has been over and over again stated expressly by the Abbe school, that we have no hope of further advance, except through increase of aperture; and on that ground was constructed the lens of 1·63 N.A. to be used with flint-glass mounts and dense fluid media—conditions under which it is practically useless. So little are other conditions recognized, that Dr. Van Heurck has only used the chromatic condenser in his skillful published diatom photographs; and those results are simply *nil*, not one of them surpassing, or in some respects even equalling, what has been done in England with 1·40 lenses.

It is far different if the Abbe theory be relegated to its proper place and proportion. Then such "lucky" objectives as the above assume a very marked significance, and hold out a world of promise: in them and in what they tell us lies the future of microscopy. Not the best even of them is probably *perfectly* corrected for all its

zones; but the best of them reveal a marvellous standard of approach to this; and with that we find ever associated an increase of that practicable cone of heterogeneous light which we have found so all-important to true contours. *And with this we get further revelation.* More *minuteness* we do not indeed get; for that we can look only to the 1·63 lens. But we have a world of structure to learn yet, *within the resolution* of our present lenses; and for that we are only waiting better condensers and better correction. It was only recently that the protoplasm so long written about as "structureless jelly," yielded up some at least of its marvellous and minute structure, which can only be seen by English wide-cone methods, with one of the exceptionally-perfect objectives here referred to; whose significance, however, as we have seen, is not yet recognized on the Continent as it is in England, and even here only by the few. It may be beyond us to-day to discover the minute departures from type which cause the superiority of the few phenomenal lenses: it is no easy thing to ascertain precisely what it is, in a lens one of whose components may not exceed a hemisphere 1-16 of an inch in diameter. But the superiority is there; it has been attained; and we may cherish reasonable hopes of such discovery. We may anticipate that the present rarest excellence may be reached yet as a standard, more generally procurable by the scientific investigator; that the very best of all may even be further improved in correction in some degree. If it be so, such advances will not be barren of results in research. The microscopist may yet hope and take courage.

PERSONAL.—Prof. W. A. Rogers died at Waterville, Maine, March 1, 1898, aged 61 years. He had been professor of physics and astronomy in Colby University since 1886 but expected to remove to Alfred University the lresent spring.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON,

CLEVELAND, OHIO.

CICADA TREDECEM.—This insect is now visiting the Mississippi Valley. It is a well marked variety of Cicada septendecem, or so-called Seventeen Year Locust or Periodical Cicada. The insect now seen is a thirteen year Cicada. It lives thirteen years underground in the larval and pupal stage and then as a perfect insect emerges into sunlight. Entomologists recognize several well-defined broods of this strange insect, the present brood being called No. VII. This brood last appeared in 1885. The brood in question ranges from Southern Mississippi and Northern Louisiana up along the river through Tennesee, Southern Kentucky into Southern Illinois, with quite a patch in Missouri. A fine treatise on this insect with illustrations is contained in the U. S. Agricultural Report for 1885 on page 233 et. seq., and illustrated page 347 et. seq.

A WHITE-FISH'S STOMACH.—The contents will be found to be almost exclusively composed of crushed remains of microscopic crustaceans, principally of Cyclops and Lychnis. What the cyclops lacks in size and weight it makes up in numbers. Should one female lay ten eggs at a time in three months she will lay eight times, so that at the end of a year her descendants would equal 4,442,189,120. If we calculate that one cubic inch will contain ten millions, then the progeny of a single female from January to December will amount to 444 cubic inches of solid food, as much as a single fish could consume.

BAZZANIA.—This is a genius of liver or scale mosses. The genus has two species in this country—trilobata and deflexa. The first species is found in wet woods and the second on rocks. They are pretty and easy to exam-

ine. Remove all dirt and examine, covered in a drop of water. Examine the slide with the cover up and also reverse the slide. Along the stems will be found the amphigastria or under leaves. It makes a beautiful show under a one inch objective. It may be mounted and well preserved in glycerine jelly.

EDITORIAL.

Postal Microscopical Club.—A 16 page pamphlet, issued by the President, R. H. Ward, M. D., and the Secretary, Dr. Shanks, contains the twenty-second and twenty-third annual reports. The club has been in continuous operation since 1885. Its membership remains about the same, and about thirteen boxes of slides pass from member to member each year through the mails. The Club reports having had some of its boxes crushed and absolutely destroyed by the rough treatment of the postal cars grabbing up mail bags on too swiftly moving trains or throwing the bags off from such trains. This only occurs at small stations, suggesting that no member should be permitted to send or receive the boxes at suburban stations. If the members are restricted to using post-offices in cities and large towns, this difficulty would be largely obviated. Another difficulty which has always annoyed the officers is the holding of boxes too long before forwarding them to the next station. As a remedy for this each member should be compelled to deposit $5 or $10 to the Treasurer so that fines may be rigorously assessed for each violation of the rules. The annual dues $1 cover the officer's expenses for slides, boxes, postage, expressage, stationary and printing.

A new special series of boxes have been in service for several months. Half of these are six-slide boxes devoted to special subjects and contributed by members who have made special studies in certain fields. The other half which are circulated alternately with the first are two-slide boxes and a few with three-slides accompanied with

Special Announcement - IN - MICROSCOPY.

DURING the last few months I have been busy preparing many rare and novel objects for Microscopical purposes, and have arranged them as under in **Illustrated Series.**

The first of these is the **Microscopical Studies in Marine Zoology.**

The second Series (viz.: that for 1895) consists of 14 splendid preparations, all of the highest possible excellence and guaranteed permanent. The 14 slides appear in quarterly installments, and are accompanied by over **100 pages of descriptive letterpress,** dealing in pleasant but exact manner with the anatomy, life-history and habits of the respective subjects, while **12 full-page plates of photo-engravings, drawn from life,** make plain all details.

Inclusive Subscription, $6.25, post-free. Full prospectus on application.

The following are among the Slides included in this Series:

1. Colony of the lovely **Radiolarian** *Sphærozoum*, showing parasitic algæ. 40c
2. The lovely Zoophyte *Obelia*, polype fully expanded. 35c
3. Stalked stage of the larva of Rosy Feather Star (*antedon*) 40c
4. An entire Sea-Butterfly (*Pteropod*). 40c
5. Lovely expanded Zoophyte *Syncoryne*. 40c
6. Lovely Expanded Zoophyte *Sertularia* 50c
7. Opossum-shrimp *Mysis*, showing auditory organ in tail 38c
8. The splendid rare organ-pipe Polyzoon, *Lichenopora* 40c
9. Entire larval Plaice, eye just turning from blind side and 5 other equally fine slides. 60c

The prices against each are those at which the preparations are sold separately, showing what a cheap lot I offer in series at $6.25, post free. A few sets of Series 1 still available, $6.25, post free. Sample Slide, 50c., post free.

Prof. J. R. Ainsworth Davis, University College, Aberystwith, writes: "Allow me to congratulate you on the very useful work you are doing by the publication of Journal, with accompanying slides, which are MOST ADMIRABLE.

Botany.

Superb microscopical preparations of **Brazilian Lianas.**—I have been unfortunate in obtaining a quantity of these superb stems—the most lovely in the whole plant kingdom—and have arranged them in two sets of 6 each, at the price of $1.35 per set, or $2 25 for the two. The most exquisitely charming slides that could possibly be imagined for exhibition at popular gatherings. As the quantity is very limited, I am unable to sell single slides.

Microscopical Studies in Botany.—In answer to many requests, I have arranged 20 magnificent preparations in a series on similar lines to that in marine zoology described above.

The first series is now begun and comprises 20 highest-class slides (such as sell singly at 25c to 35c each), illustrated by descriptive letterpress and 20 specially beautiful photo-micrographs of the sections.

Subscriptions, $6.25 only, for all, a sum which would be cheap for the series of illustrations alone.

Prof. J. W. Carr, University College, Nottingham, writes: "Your Botanical Slides are the most beautiful I have ever seen. The following are among the slides already issued in above lines:

1. Tr. sec. flower-bud of Lily 25c
2. " " do of Dandelion 30c
3. Long'l sec. do of do 25c
4. do fruit of Fig 30c
5. Tr. sec. fruit of Date (splendid) 35c
6. " " flower of *Eschscholtzia* 30c
7. Long'l. sec. double flower of Peony 25c
8. Leaf-fall of Sycamore 25c

I guarantee the **perfection** of all my mounts and will be pleased to send selections on approval to approved correspondents.

A great range of Miscellaneous Zoological and Botanical slides in stock at prices from $1 30 per dozen.

Cost of Mailing. 1 slide, 10 cents; 2 slides, 15 cents; 3 slides, 20 cents and so on. Large parcels by express at very cheap rates.

Speciality. Marine Zoology (especially in expanded Zoophytes and larval stages, and plant and flower anatomy.

Terms. Remittance by P. O. O., draft on London, or U. S. paper currency, the former preferred. If wished, Mr. C. W. Smiley, Washington, D. C., will hold the amount till order is satisfactorily executed. Mr. Smiley has kindly promised to vouch for the excellency of the slides and will give references to U. S. Microscopists who have been well satisfied with my preparations.

JAMES HORNELL,

Biological Station, Jersey, England. Specialist in Microscopical Mounting.

THE AMERICAN

7363

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. DECEMBER, 1898. NO. 12.

Contents.

An Episode in the Artificial Culture of Diatoms.

BY WILLIAM A. TERRY,
BRISTOL, CONN.

Late in August, 1895, I made a gathering of sediment from the margin of a pond in Bristol at an elevation of some 800 feet. The water was low in the pond and had left this sediment uncovered for some time. The previous year I had made a similar gathering from the same place, and, on stiring it up in water found it very rich in desmids, numerous in variety and some of them very rare. This gathering contained also numerous varieties of desmids, but not in sufficient quantity to be easily separated from the mud. It had also diatoms, particularly Surirelia biseriata, and, as I believed it contained spores also I gave them a chance to develope. Stiring it up in water, after the sand and coarse debris had settled, I poured the lighter part into a glass dish about one

foot in diameter. The material formed a sediment about one-half inch deep with three inches of water over it, about one quart in all. I placed this in a cool room exposed to a strong light. In a few days a curious growth developed at points all over the sediment. This growth resembled a miniature moss, clubshaped, with a dark green top shading from pale green to light brown in the stem. Dozens of these peculiar growths appeared, about one-half inch in height and all very similar in form and coloring. The stem had no elasticity. When pressed carefully down it would remain on the bottom for some time but would finally rise up again upright. I pulled up one of these carefully with tweezers. The part below the mud was dark brown in color and resembled a root. Placing it on a slide under a one-inch coverglass, I found the green top to be composed wholly of desmids, magnificent specimens of Microsterias radiosa in all its various types with M. furcata and M. americana and many others, a dozen species of Closterium, as many of Cosmarinm, with Penium, Euastrum, Staurastrum, Docidium and many others, some of them unknown to me. All made up a rare collection of varieties which I had never before seen equaled. The stem was made of a tough mucous which contained small varieties of Cosmarium, Penium and Euastrum, but was chiefly filled with minute species of diatoms, Navicula, Amphora, Nitzschia, and a somewhat larger variety which from their darker color and slightly bellows shape I concluded to be developing Surirella. The root was composed chiefly of gelatinous hydrate of iron oxide. By the disturbance caused by the pressure of the cover-glass thousands of the diatoms were liberated and were rapidly traveling to and fro in all directions. These diatoms, were of well-known species, and most of them appeared to be destitute of silex. I considered them immature forms.

As they were protected to some extent by their gela-

tinous matrix from the attacks of the Ciliata and Amœba, I hoped they would survive long enough to develope sufficiently to settle this question, and I watched them with great interest from day to day. That there should have been so many of these peculiar growths I thought remarkable. I had often before noticed the tendency of the desmids to climb upon projecting points, and probably the buoyancy given by the gases liberated by their vital processes was sufficient to stretch out the yielding gelatinous envelope of the diatoms into this shape.

Destructive animals did not appear very abundant. There were many rotifers but they live upon minute organisms circulating in the water. Around the root and climbing upon the stem of this growth under examination, I counted fifteen of those very curious sloth-like creatures, the Tardigrade or Water Bear. Some of these were very large, but, as the contents of their stomachs was colorless, they did not appear to have been feeding upon diatoms. Although I have watched these animals for a considerable time in hundreds of instances, I have never seen them feed. Notwithstanding, their formidable claws do not appear to me to be very destructive. Their comical contortions while painfully clambering over the debris look appealing rather than ferocious.

In a very few days it became evident that these growths were being rapidly devoured. Every morning a larger tract was cleared until finally all were gone. I then poured off the whole and strained it through a fine wire sieve, capturing a large number of that miserable crustacean,the aquactic representative of the common sow bug, a freshwater relative of the so-called sandflea of the seashore. This is the most omniverous destroyer I know. Fish, flesh and fowl come alike to him including animals, plants, vegetables, algæ, fungus, desmids, and diatoms; and he will even devour their empty shells. During the three years that have passed since these oc-

currences, frequent observations have been made, but no more of these peculiar growths have formed, although the material still contains living desmids and diatoms. Numerous colonies of minute diatoms enclosed in gelatine have formed but have not persisted long enough for conclusive results. A drop of the sediment now under observation shows six species of desmids, countless numbers of empty frustules of large Surirella and a few living ones, but their number has been constantly diminishing for a year past. A few specimens of Surirella biseriata still live but are very sluggish. S. splendida are nearly all dead, but active frustules of a very elongated type of S. elegans still survive. I wish those scientists who believe that the motions of the Surirella are confined to a "languid roll" could see one of these ploughing its way through the debris and crossing the entire field of the microscope in a little over one minute. Two or three species of Pinnularia also appear healthy.

A New Photo-Micrographic Apparatus.

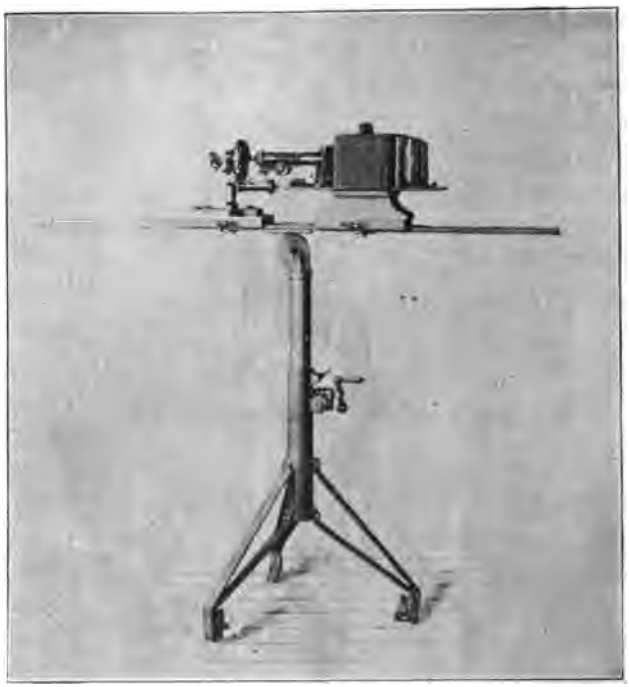
A. W. Bitting, Lafayette, Ind.

The apparatus consists of an upright cast-iron post supported by three cast legs. The center of this post is bored out to receive the elevating post. Near the top is a sprocket wheel, which is turned by a screw and crank. A binding screw is also placed in the top to clamp the elevating post in position. The upright post, with its legs, stands 28 inches high. The elevating post is 28 inches long, is of two-inch steel tubing, turned to fit the hole in the upright post. A series of holes are drilled into the tubing to receive the sprocket wheel, which raises and lowers it. Upon top of the elevating post is a head-post which receives the bed plate for carrying the camera and microscope. The head-post is turned

to exactly fit the inside of the tube and permits the bed plate to be revolved on its horizontal axis. The bed plate is five feet long and five and one-half inches wide. It consists of a piece of three-sixteenths-inch rolled

steel, to which is riveted two dressed half-inch steel tubes. These tubes are placed near each edge and give rigidity as well as serve for guides for the camera and microscope carriages. In the centre of the bed plate is a rack for the adjustment of the camera and microscope

The attachment of the bed plate with the head post is by two dressed circular surfaces and a bolt. Upon the head post is mounted a screw which turns in threads cut upon the edge of the circular plate attached to the bed plate. By loosening the bolt and turning the crank upon the end of the screw the bed plate may be made to rotate upon its vertical axis.



The carriages are twelve inches long, grooved to fit upon the steel rods, and are provided with pinions, cranks and binding screws to make accurate adjustment. The stand is provided with castors so adjusted that it may be thrown on or off its legs with the foot. All the handles are nickel-plated and the whole apparatus enameled black.

The requisites of a good photo-micrographic apparatus are rigidity, ease and accuracy of adjustment and adapt-

ibility to all kinds of work. The first condition has been met by using metal in the construction, thus obviating shrinking, swelling and warping, inherent qualities of wood. The second and third requirements have been met in the mechanical construction.

With this apparatus it is possible to work in the vertical or horizontal position or at any inclination. The adjustment is easily and quickly made by loosening the binding nut between the friction plates aud turning the bed plate to the desired position. The bed plate can be rotated on the horizontal axis to get the advantage of room and direction of light without moving the stand upon its legs. When the bed plate is turned to the horizontal the top of the bed plate is 33 inches from the floor; too low to work with comfort. By raising the elevating post the bed plate may be carried up to the height of five feet. This adjustment makes it possible to always have the work at a comfortable height, either in sitting or standing position, and regardless of the stature of the operator.

Diagnosing Yellow Fever.

In an official hand-book on yellow fever, its nature, diagnosis, treatment, and prophylaxis, which has just been prepared by the Surgeon-General's Office, Acting Assistant Surgeon John Guiteras says regarding the use of the microscope:

"An erroneous belief has prevailed throughout the South, especially among physicians who were not practical microscopists, that the microscope should be an important aid in diagnosis of yellow fever. It appears that poorly prepared abstracts from the work of Sanarelli have led many to believe that a characteristic feature, the bacillus of Sanarelli itself, was found on examination of the blood. Now the truth is, that even with the as-

sistance of post-mortem examinations, Sanarelli was able to discover his bacillus in only 58 per cent of the cases of yellow fever. He would be a poor clinician, indeed, who could only diagnose about one-half of the cases. The truth is, however, that during life the microscope could not establish a positive diagnosis. As far as our present methods go, it would be impossible to distinguish between a drop of yellow fever blood and blood from a healthy man. Negative evidence may be presented by the microscope. The presence of the plasmodium malariæ, for instance, would prove that a case was suffering from malarial poisoning, and presumably not with yellow fever. But the differential diagnosis between these two diseases is usually easy. The billious remittent fever that in our old text-books of medicine occupied a conspicuous place in the tables of differential diagnosis with yellow fever, has practically disappeared from the Southern sea border since yellow fever ceased to be an endenic there. It was, in fact, the yellow fever of the natives and of places in the interior. The former were supposed to possess in a certain degree immunity against yellow fever, and the disease was believed to be restricted almost to the littoral. The plasmodium has been found in the blood in cases of yellow fever. The mistake made by the board of experts of New Orleans, when they failed to recognize the existence of yellow fever at Ocean Springs, was due to the finding of the plasmodium in at least two of the cases."

In February, 1896, Sanarelli discovered and named the Bacillus icteroides having found it in 58 per cent of the cases of yellow fever examined. Why could he not always find it? He states that in laboratory work these bacilli are quickly killed off by the common pus organisms, the colon bacillus and others. Having gained entrance to the circulation through the destruction of the natural barrier by degenerative changes brought by the

icteroides, these other organisms proceed at once to kill off the icteroides. By inoculation, Sanarelli produced a disease much resembling yellow fever, but the analogy was not so strong as desired. The symptoms and pathological changes differed sufficiently from those produced by other organisms to warrant the belief that the yellow fever was actually produced. Serum from convalescents or from yellow-fever cadavers produced only slight agglutination of the icteroides. Antidiphtheritic serum produces rapid agglutination of the bacillus, which would indicate a close biological relationship between it and the Klebs-Loeffler bacillus. There are points of resemblance in the manner in which the infection of yellow fever and diphtheria spread. Typhoid serum also produces this phenomenon but partially, and, as would be expected, colon serum and that from normal man produces no effect. Serum from a convalescent possesses no curative action in the guinea pig simultaneously with the minimum fatal dose of icteroides, but 2 c. c. of the same serum administered 24 hours previous to the minimum fatal dose seems to confer immunity,—at least, the pig does not die. A horse has been immunized to the icteroides and .5 c. c. of his serum will give to the guinea pig the immunity above mentioned under the same conditions, and even after 48 hours has been allowed to elapse, 2 c. c. will save the animal. Saranelli used the serum of a horse inoculated with gradually increasing quantities of the icteroides for 18 months. In Brazil, he treated 8 cases with subcutaneous injections, the total quantity varying from 15 c. c. to 65 c. c. with a mortality of two. Many able and conscientious investigators are still working to verify the researches of Sanarelli and it is hoped they will succeed at an early date.

Fixing Blood for Microscopic Study.

Complex technique in the preparation of microscopical preparations has done more to limit the use of the microscope in the diagnosis of disease than any other one thing. Take the ordinary directions for the preparation of a blood slide. First the most careful soaking and scrubbing of cover glasses, then the application of one of the glasses to the drop of blood, followed by a second cover glass laid over the drop and the two pulled slowly apart, with the result that in fully half of the cases neither of the two cover glasses is spread in any way suited to the purpose; either no blood adheres or the corpuscles are found overlying one another,or matted to such an extent as to make them worthless. Finally, if a good spread is secured, fortunate is the ordinary worker if he does not find, after following the advised heat method for fixing, that he has not fixed the corpuscles, but simply distorted them.

The following method of blood preparation requires only ordinary skill and presents the advantage of almost invariably giving first-class specimens. A solution is prepared which will mechanically separate the corpuscles of blood mixed with it, and yet of such density and composition as to permit them to retain their proper shape and condition. There are several such solutions. The formula suggested by Hayem is as follows:

Chloride of sodium.....	1 part.
Sulphate of soda.....	5 parts.
Bichloride of mercury.....	5 parts.
Distilled water.....	200 parts.

Drop a few drops—about five—of this solution in a small test tube or vial. Then after scrubbing the skin with alcohol or ether, puncture with a triangular surgeon's needle. With a small wire loop or a pointed glass rod quickly transfer a very small drop of blood from the

surface of the skin into the solution and stir thoroughly. Use a looped wire, similar to the platinum loop used in transferring sputum to a slide, but with the loop made smaller. Now the blood may be carried any distance without change. This is all that is necessary to do at the bedside, and the subsequent manipulations may be made at leisure. When it is desired to continue and complete the examination, a slide and cover glass are cleaned in the ordinary way, the mixture of blood and Hayem's fluid is stirred or shaken, and a small drop placed upon the slide. If a stained preparation is not desired, the mixture is covered with a cover glass and examined at once. It will be seen that all the corpuscles are separate, with no tendency to collect together, and not distorted.

If it is desired to prepare stained specimens, then after the small drop is placed upon the slide it is to be subjected to the following manipulations. The following solution is to be used:

Formaline	8 drops.
Alcohol	3 drachms.

A quantity equal to twice the bulk of the blood solution which had been placed upon the slide is now placed also upon the slide, so that the blood solution and formaline in alchohol solution shall come in contact by their sides. At once it will be noticed that the blood is being precipitated as a very fine white precipitate. The slide should now be left to lie perfectly flat for at least one minute, after which time fixation is complete.

Now the fluids may be allowed to evaporate slowly, or if it is desired to rapidly complete the process, small pieces of blotting paper may be applied to the edges of the fluid, and some of it cautiously absorbed, always watching the white precipitate to see that it is not also removed by the blotting paper. When but little of the fluid remains, gentle heat may, in my experience, be used

to facilitate drying without detriment to the specimen. The blood is now fixed to the slide, and may be stained in any way desired. When the formaline and blood solutions are brought in contact, a rather violent movement occurs, due to the difference in densities between the two liquids, and if the formaline solution is dropped directly upon the blood solution, the latter will be forced to the sides and the specimen will not be a uniform spread, but rather in the form of a ring, which, of course, is of no importance whatever.

Those who desire to make permanent mounts, and, desire neat-looking specimens, should mark out upon the slide a square, a little smaller than the cover glass, by taking a small camel's hair brush or a match and dipping it in collodion and marking out a hollow square. In the middle of this square I place the blood solution, and then the formaline solution, and unless the quantity of each is excessive, the fluids are accurately confined by this collodion wall during the mixing, and after the fluids have dried the collodion will easily peel off by using a pin leaving a specimen with sharp-cut edges.

There is no doubt as to the value of the alcohol formaline solution as a fixative for the corpuscles. A good smear may be made by dragging the slide its whole length over the drop of blood on the ear or finger-tip. Such smear may be at once set by pouring the formaline alcohol solution over the slide. After drying, the blood may be studied directly without cover glass, using an eighth objective. Wherever the smear is thin and well spread, abundant corpuscles will be found, which are not drawn out of shape or vacuated by the formaline-alcohol.

The great advantage of the Hayem's solution is that the blood may be kept for an indefinite time and examined at leisure. Ten minims of the salt solution should be put in a half-drachm vial and a small drop of blood added. After mixing with formaline-alcohol solution on

the slide, and drying, a confusing mass of needles and crystals are found mixed up with the scattered corpuscles. This crystalline debris, may be washed away by pure water gently dripped on the slide without disturbing the corpuscles. They may then be colored with the eosin and methyl blue solutions in succession, covered with cover glass, and examined with a twelfth oil-immersion at leisure.

The methods suggested may be tried by those accustomed to fixing blood with the alcohol-ether solution, or by heat, or by saturated alcohol sublimate solution, and the relative results compared.

For staining the malarial organism after fixing the blood corpuscles, the method is:

1. The specimens are stained with eosin (one-half of one per cent eosin in ordinary alcohol) for five to fifteen minutes; the solution will not stain too deeply.

2. Wash in running water and dry in air.

3. Stain with methyl blue (one drachm of the laboratory solution to an ounce of water is strong enough), the time it takes to count ten—eight to ten seconds is long enough.

4. Wash in running water, dry, and mount in balsam. The blue stain colors the parasites: the danger is in overstaining with the blue. Good success is had by using a 10 per cent solution of methyl blue in alcohol, staining two or three minutes. But for the crescentic forms of the æstivo-autumnal fevers which stain with more difficulty than the ordinary forms of tertain type, the watery solution of blue is necessary.—*Ind. Med. Journal.*

Practical Suggestions.

By L. A. WILLSON,
CLEVELAND, OHIO.

FLAGELLUM OF CERATIUM.—The flagellum of this animal when present is easily and plainly visible under an ordinary and inexpensive one-quarter-inch objective. It needs no staining nor a high angled expensive lens. The flagellum is seldom seen as the little animals are quite timid and at the slightest alarm retract this interesting appendage. It has been suggested that the animals pass into a "still condition" and in that state retract the flagellum.

FLAGELLUM OF BACTERIA.—These illusive organs may be plainly and comfortably viewed with a cheap one-fifth when properly stained. The difficulty in demonstrating these minute organs lies not with the lens but with the lack of skill and technical knowledge in the method of staining. To stain them requires experience, technical knowledge and special skill.

GUM FOR FIXING OBJECTS TO A SLIDE.—Selected pieces of gum arabic are dissolved in distilled water, so as to form a thin mucilage. This is filtered, and the filtrate poured into a considerable volume of alcohol, which precipitates the arabic. This is separated from the mother liquor by filtration, washed with alcohol and finally dried. It is freely soluble in water and can be used instead of the ordinary gum with advantage. It will obviate the granular appearance of the gum when used to fix objects to a slide.

BLACKENING THE INSIDE OF A DRAW-TUBE.—Many fine instruments are sold with the inside of the draw-tube covered by a bright metallic surface. With such an instrument it is impossible to obtain good photomicrographs or even to obtain a good deffinition. The following is a process for obtaining a dead black surface on

brass :—Put two grains of lamp-black into any smooth, shallow dish, add a little gold size and thoroughly mix the two together. Just enough gold size should be used to hold the lamp-black together. About three drops of size, as may be had by dipping the point of a lead pencil about half an inch into the gold size, will be right for the above quantity of lamp-black. After the above are thoroughly mixed and worked, add twenty-four drops of turpentine and again mix and work. Apply thin with a camel's hair brush, and when dry, a fine dead-black will result.

PRACTICE.—It requires considerable experience to interpret correctly the objects viewed in the field of a lens. It is generally impossible for a person unaccustomed to the instrument to know precisely what the field exhibits. When experts bring their instruments into court judges and jurors often take a look at an object and draw the most erroneous conclusions. Air bubbles, oil bubbles, stray debris and accidental particles are apt to most strongly engross the attention.

MUSCA DOMESTICA.—This is a common house-fly. On account of the conformation of its mouth parts, this insect cannot bite. Common and wide-spread as this species is, there is very general ignorance as to its life history and habits, except in its adult stage. Its length of life in the adult condition is not certainly known. In a warm climate it produces ten to thirteen generations every summer. A single fly will lay an average of one hundred and twenty eggs. Stables are their chief and favorite breeding places. They are carriers of contagion. In the autumn, they are attacked by minute reddish mites. As many as nineteen of these mites have been found on a single fly. Soak the fly in a shallow vessel in turpentine when the mites will crawl off and may be examined and mounted.

EDITORIAL.

Periodical.—It is unfortunate that the monthly, "Natural Science," is to lose its editor and perhaps its life with the end of the year, but while it lives it kicks, calling the Scientific American in its August number "an American Pirate," and accusing it of repeatedly stealing from the columns of Natural Science.

Cells.—At the late meeting of the British Association for advancement of Science, forty pounds ($200) were appropriated for Prof. E. A. Schafer to use in research upon the micro-chemistry of cells.

Diagnosing Diphtheria.—Jaques urges early bacteriological examination in all anginas. In malignant cases make a direct diagnosis. Take a little of the mucous or of the membrane directly from the site of the invasion. Spread it on a cover-glass or slide, fix by heat, stain and examine. In other cases a culture should be made. Jaques has laid aside the laboratory test-tube and substituted a small metal culture box. Having inoculated it he carries it in the vest pocket where the heat of the body keeps up the proper temperature. After three or four hours he makes the examination.

Phyto-Plankton.—George Murray and V. H. Blackman have studied the nature and extent of the little understood microscopic objects called coccospheres and rhabdospheres. Their calcareous plates are described in minute detail. The coccospheres have a central green chromatophore which separates into two on the division of the cell. These plants belong to the unicellular algæ. They are found on the surface, in deep-sea deposits and in fossil beds.

Forest Leaves.—Microscopic observation of the living leaf reveals that the chlorophyll granules are individually independent globules of dense protoplasm, without proper walls, plunged in the midst of the fundamental protoplasm and tinged by the green matter, their form and size remaining unaltered when extracted by ether, etc.

SCIENCE-GOSSIP.

Decaying Pine Wood.—J. S Dales reports a peculiar condition in a tree box. The decayed portion did not present the usual dull, dark, shrunken appearance common to rotten wood. Above the line of moisture, it was of bright, buff color, glossy and velvety to the touch but, upon slight pressure it crumpled into powder leaving a small mass of coarse and hard wood-fibers. Microscopic examination revealed a dark intersticial fungus and a great abundance of minute spore-like bodies which resisted many of the usual staining fluids.

Nucleo-albumin.—For anæmia, Dr. E. D. Klots, 156 W. 48th street, New York, has given haemabolqids, half an ounce four times per day, with the result of increasing the haemaglobin in two months from 41 to 69 per cent, the red blood-copuscles in ratio of 198 to 364 with a corresponding return of health. In another case the haemaglobin increased from 38 to 63 per cent and the red blood copuscles in ratio of 164 to 341. Photomicrographs of he blood before and after treatment are shown in the N. Y. Med. Jour. of Nov. 12, 1898.

Circulation of Blood.—The standard method of examining the circulation is that of extending on a frog-plate the web between the toes of a frog's foot. As, however, most amateur microscopists find it difficult to obtain a frog when they require one, it might be of advantage to some of them to know that the tadpoles of the common frog form excellent substitutes during their embryonic state, and that in the thin expansion of the tail the circulation is exhibited to perfection. These tadpoles are easily obtained in almost any district, and may be kept in a small aquarium or fish globe, where they will be handy when required. The method of examination is very simple. The tadpole is caught and transferred to an ordinary slide, and a lump of loose wet cotton-wool is placed over it, holding it down fast to the slide, and leaving the tail free for observation. If there is any tendency to curl the tail up on to the

object-glass, an ordinary thin glass cover may be placed over it to keep the tail steady. The tadpole can be kept thus for an hour or more withoutany apparent discomfort, provided that the cotton-wool be kept moist. It might be mentioned that the tadpoles are of very little use for this object after the development of the legs, as the circulation then ceases, and the tail becomes opaque. I always use a one-inch objective and dark ground a illumination.—*Lewis H. T. Chase in Science Gossip.*

Photo-micrography with High Powers.—In "Nature" Messrs. J. E. Barnard and T. A. B. Carver explain how they have overcome the difficulty experienced in photo-micrography with high powers and critical illumination, owing to the unequal intensity of the light emitted from the surface of incandescent limes, or the impossibility of controlling the electric arc so as to maintain a constant position and condition of the crater on the positive carbon. The latter difficulty has now been overcome by having a simple form of hand-feed apparatus, with a pinhole camera attached, through which an image of the carbon points is projected onto a ground-glass screen. With such a form of arc-lamp absolute "centration" of the light can be secured and mantained, without reference to the microscope, after the necessary position of the image of the arc on the screen of the pin-hole camera has been once obtained.

Effect of Different Media on Micro-organisms.—Professor Bitting has found by making ten exposures each of air, water and milk upon four different media (neutral agar agar, neutral glycerine agar, neutral beef gelatine and slightly acid wort gelatine) using some closed petri dishes all under like conditions, that agar agar gave the most bacteria and wort gelatine the most moulds. The average number of colonies of bacteria developed by ten tests of air was: On agar agar, 86; glycerine, 73; beef gelatine, 64; wort gelatine, 41. Ten tests of water gave the following number of colonies: Agar-agar, 2,370; glycerine agar, 2,260; beef gelatine, 1,470; wort gelatine, 480. Ten tests of milk gave the following

number of colonies; Agar agar, 7,967 ; glycerine agar, 11,207.; beef gelatine, 7,416; wort gelatine, 1,700. Agar agar shows the highest number of colonies. The average number of moulds from air was as follows: On agar agar, 3, glycerine agar, 7 ; beef gelatine, 20 ; wort gelatine, 34. Ten tests of water gave: Agar agar, 12; glycerine agar 15 ; beef gelatine, 60 ; wort gelatine, 88. Ten tests of milk gave: On agar agar, 2 ; glycerine agar, 7 ; beef gelatine, 12 ; wort gelatine, 47. Wort gelatine showed the highest number of colonies of moulds. Hence, statements of the number of forms found, are of little value unless the media are taken into consideration.

RECENT PUBLICATIONS.

New Book.—The Microscopical Proof of a Curative Process in Tuberculosis, or the Reaction to Tuberculin Evinced by Blood Changes hitherto Unrecognized, by Chas. Denison, M. D., Denver, Colo.

Mushrooms.—The Asa Gray Bulletin for October is especially devoted to the Amanita and seeks to notice mosses, lichens and sedges.

Tumor of the Jaw.—In the transactions of the Manchester Microscopical Society for 1897 is a paper by Mr. Worstenholme on Botriomyces, a micro-organism that produces tumor of the jaw, chiefly in oxen. It was formerly known as osteo-sarcoma, a malignant cancer.

Algae.—A list of the Fresh water algæ of Queensland, has been issued by the government at Brisbane.

The Double Man.—This story reminds us of the novels of Bulwer, being filled with information of the sort that most men refuse to accept as truth and with recitals which most men declare to be imaginary. The very knowledge that most of all we shall sometime wish to have is covered under the false label of fiction. We now only amuse ourselves and forget the tale. Send fifty cents to Paul Tyner Denver, Colo., therefore and be amused with what he writes of man's powers in the occult realm.

Someday, when the non-material in us has evolved to higher planes and subordinated the material we shall find a higher use for this kind of literature than we make of it today.

MISCELLANEOUS.

For Sale.—A high-class microscope by a renowned English maker. High-angle objectives, 2-3, 1-6 and 1-12 oil imm. achromatic Abbe condenser, &c., &c. A bargain. Apply to Dr. Thomas, 222 Sansome St., San Francisco.

Dublin Society.—The Irish Microscopical club that has heretofore met at the residence of its members is to meet in the future at the rooms of the Royal Dublin Society.

Society.—The Hastemere Microscope and Natural History Society contains 452 members and has an annual income of $350. Mr. Grant Allen, the president, urges upon its members to each select some one branch of Natural History and endeavor to contribute something thereupon to the society.

Personal.—Dr. C. T. Caldwell is professor of Microscopy and Histology in the Medical Department of the National University, Washington, D. C. Dr. Willlam B. French is professor of Bacteriology in the same college. These branches are taught by lectures and laboratory work consisting in the preparation and examination of microscopic sections, the making of cultures and familiarity with bacteriological technique.

Personal.—Thomas King, one of the founders of the Microscopical Society of Glasgow, Scotland, which was founded in October, 1884, died Sept. 14, 1896. His biography has been published by the Natural History Society of Glasgow. From 1884 to 1896 he was an officer of the Microscopical Society, and being a skilled microscopist and having a thorough knowledge of vegetable tissues, as well as of lower plant forms he was able to read many valuable papers before the society.

Personal.—Dr. E. J. Lutz is Professor of Bacteriology in the Medico-chirurgical college of Kansas City, Mo.

THE MICROSCOPICAL JOURNAL.

INDEX.